Autonomous Vehicles for Mars Exploration

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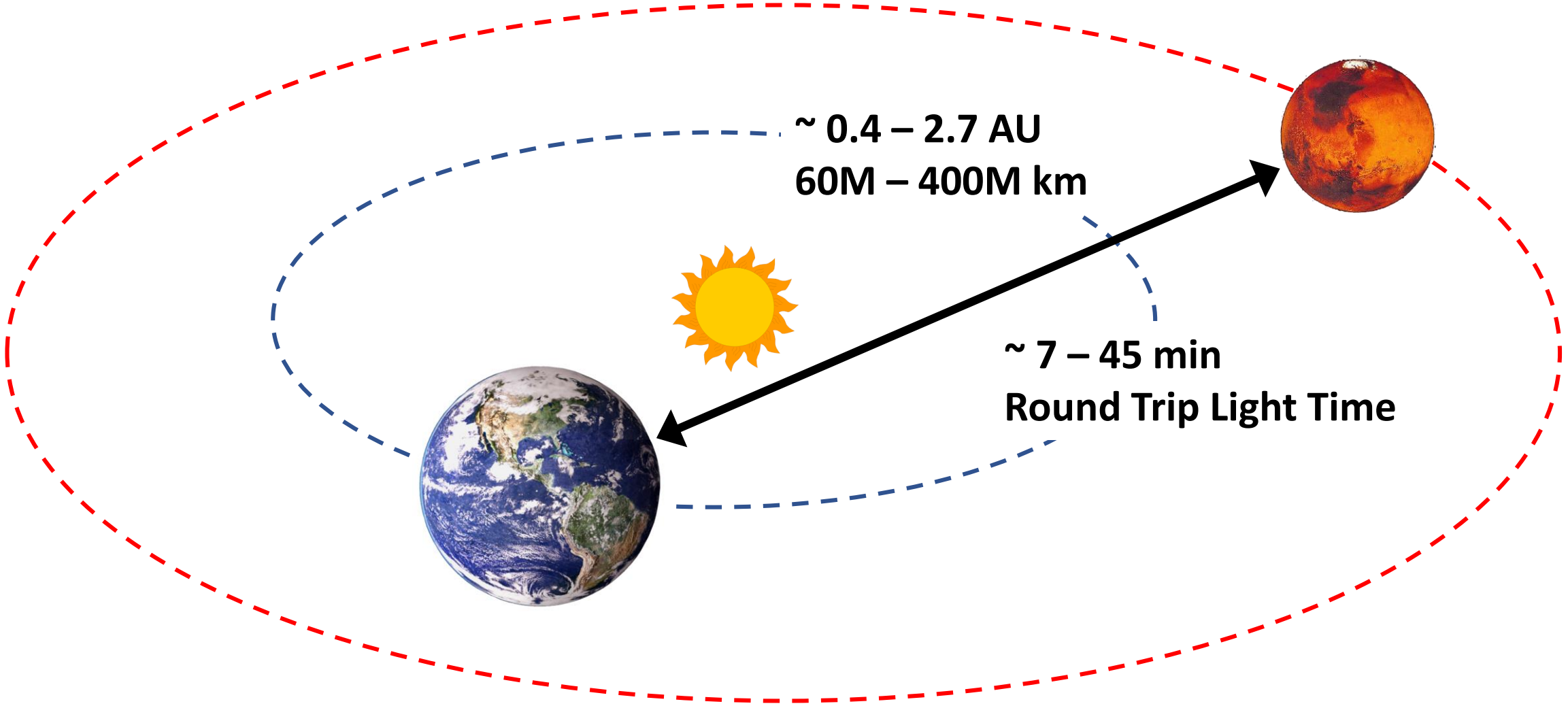
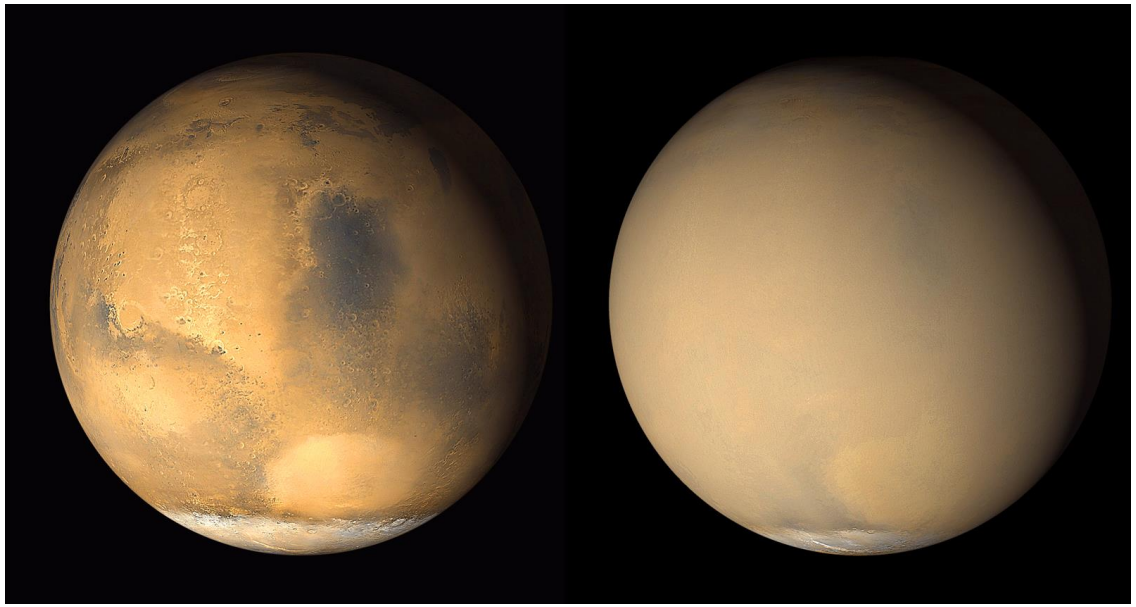
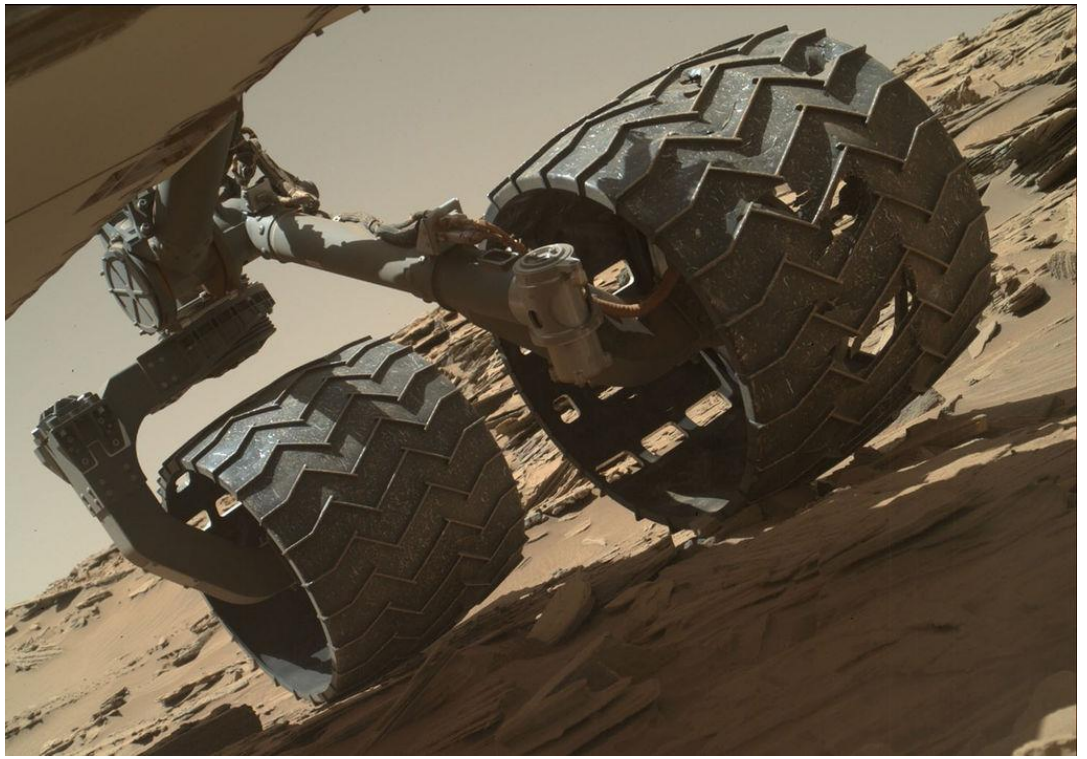
Key drivers for autonomy: Long Round-Trip Light Time



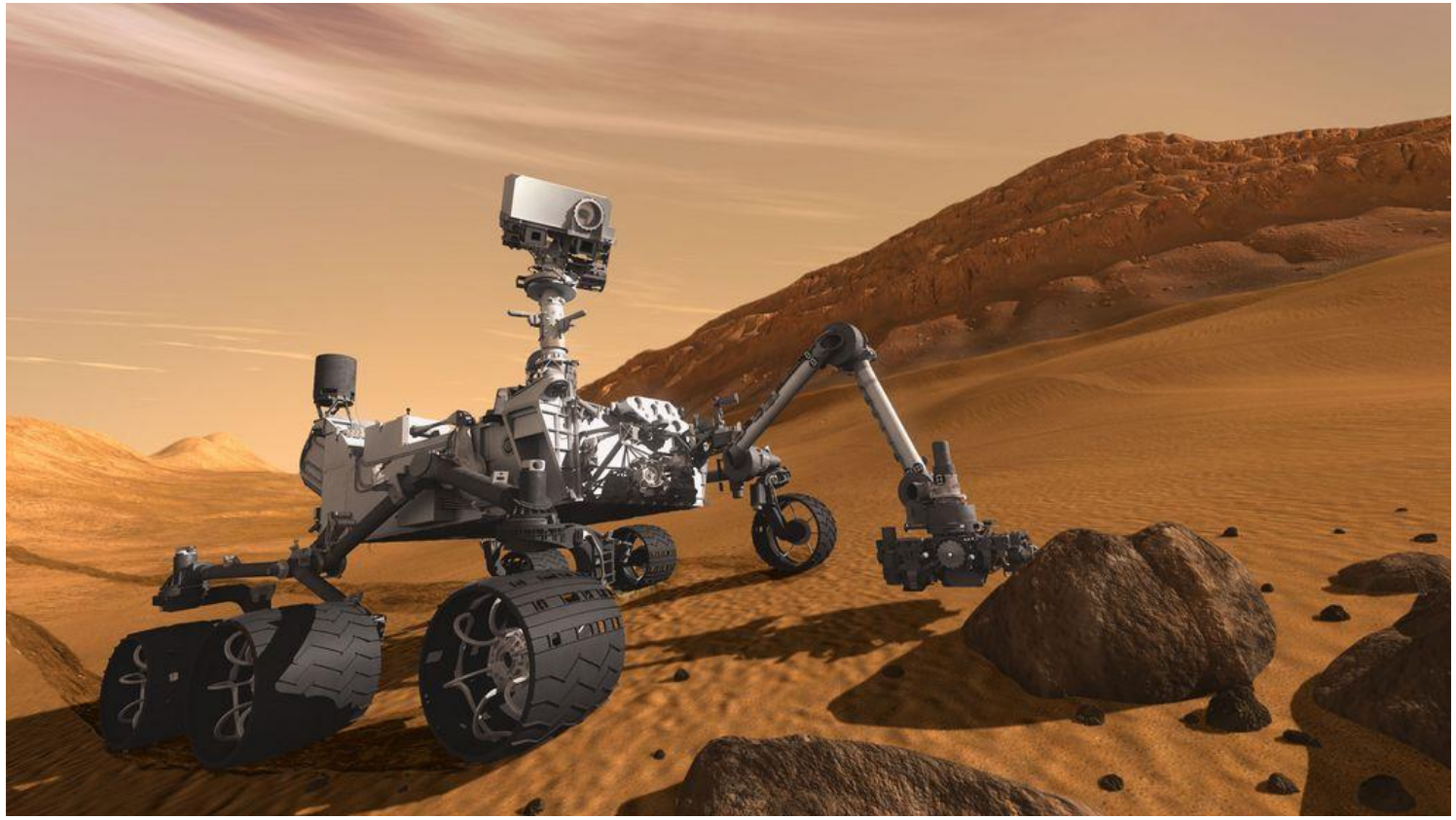
Key drivers for autonomy: Unpredictable Environments





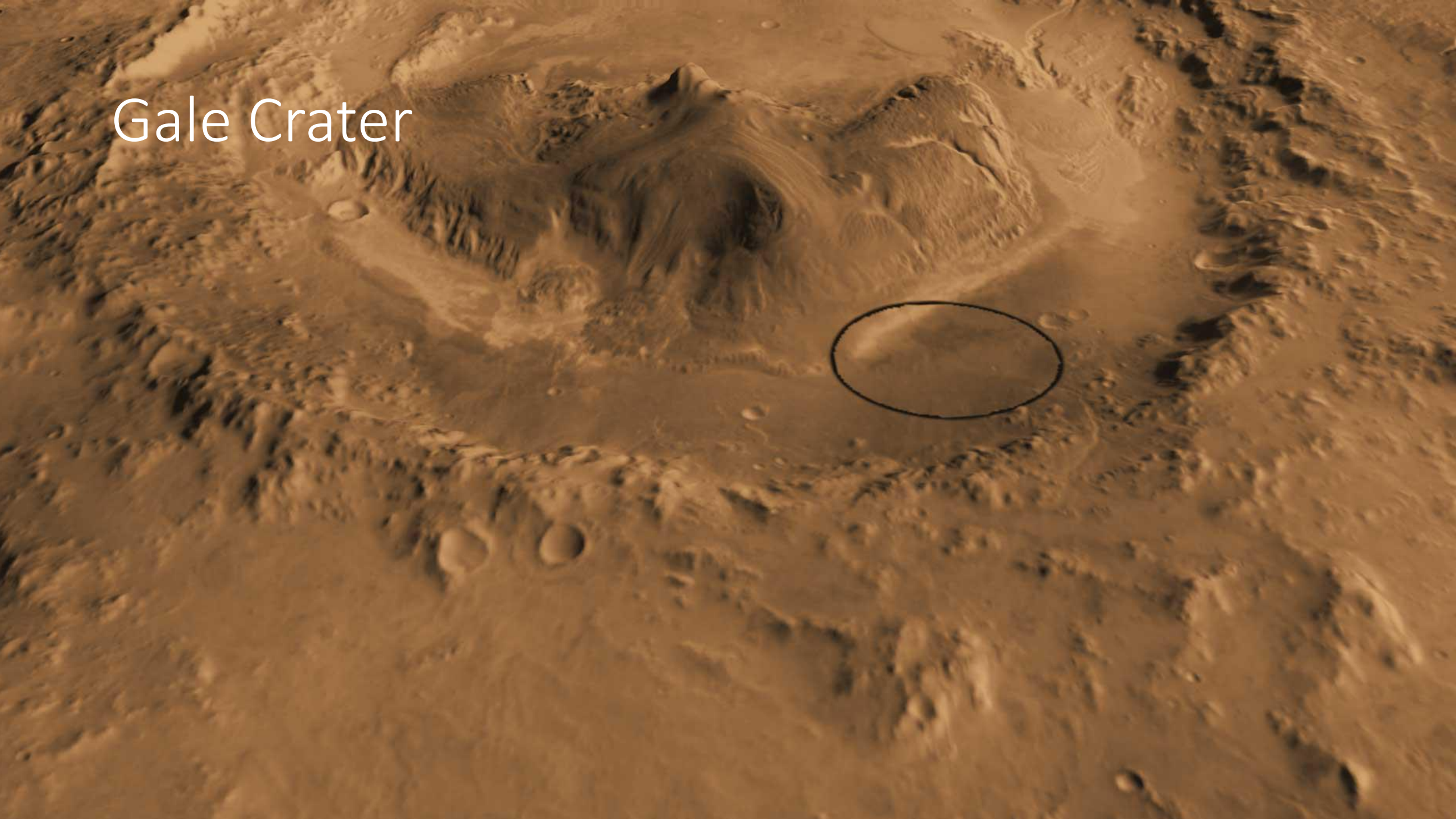
Key drivers for autonomy: Contact Investigations

Curiosity Rover

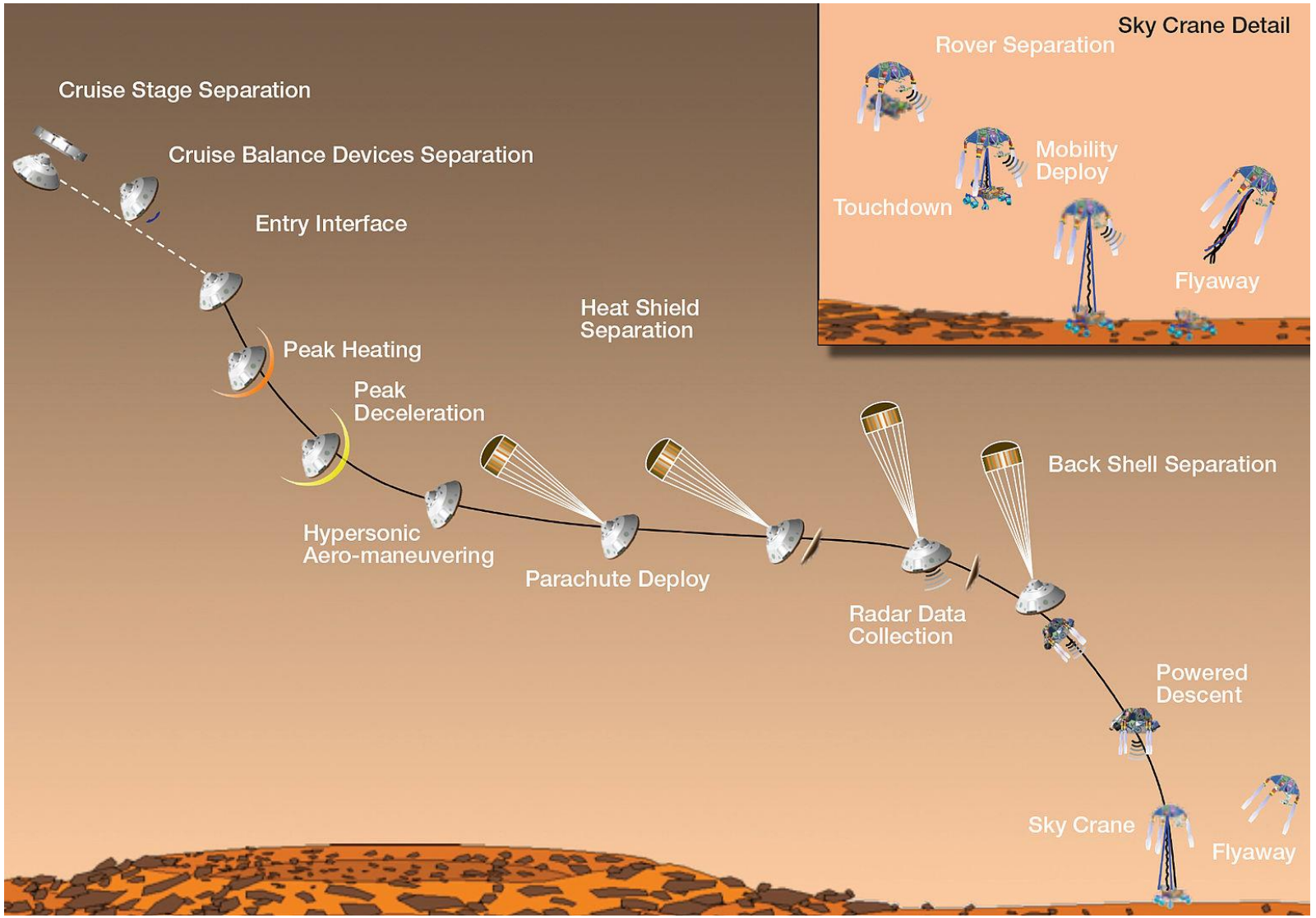


Cameras	• Mast Camera (Mastcam) • Mars Hand Lens Imager (MAHLI) • Mars Descent Imager (MARDI)
Spectrometers	• Alpha Particle X-Ray Spectrometer (APXS) • Chemistry & Camera (ChemCam)
Analytical Instruments	• Chemistry & Mineralogy X-Ray Diffraction/X-Ray Fluorescence Instrument (CheMin) • Sample Analysis at Mars (SAM) Instrument Suite
Radiation Detectors	• Radiation Assessment Detector (RAD) • Dynamic Albedo of Neutrons (DAN)
Environmental Sensors	• Rover Environmental Monitoring Station (REMS)
Atmospheric Sensors	• Mars Science Laboratory Entry Descent and Landing Instrument (MEDLI)

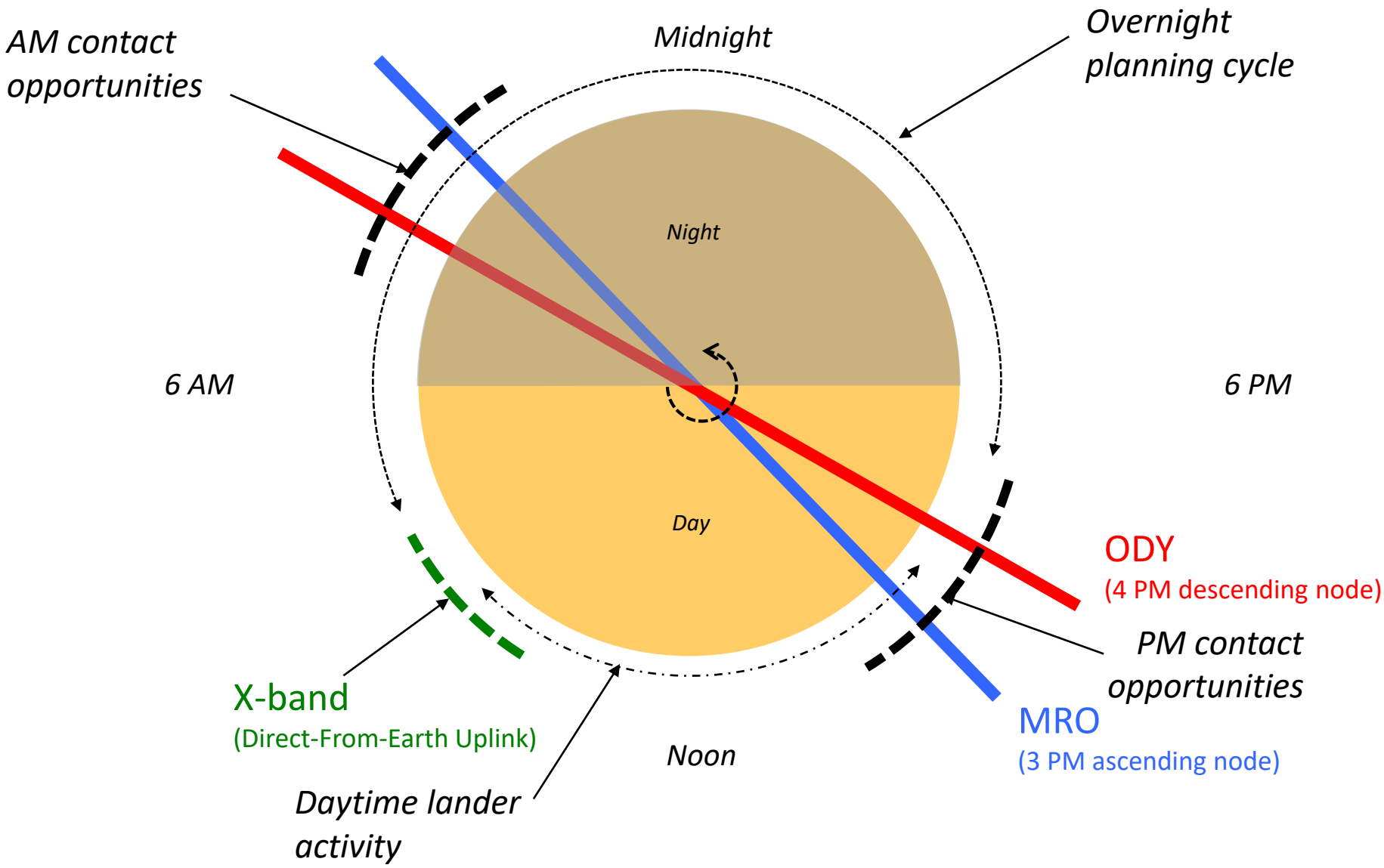
Gale Crater



Autonomy for Landing



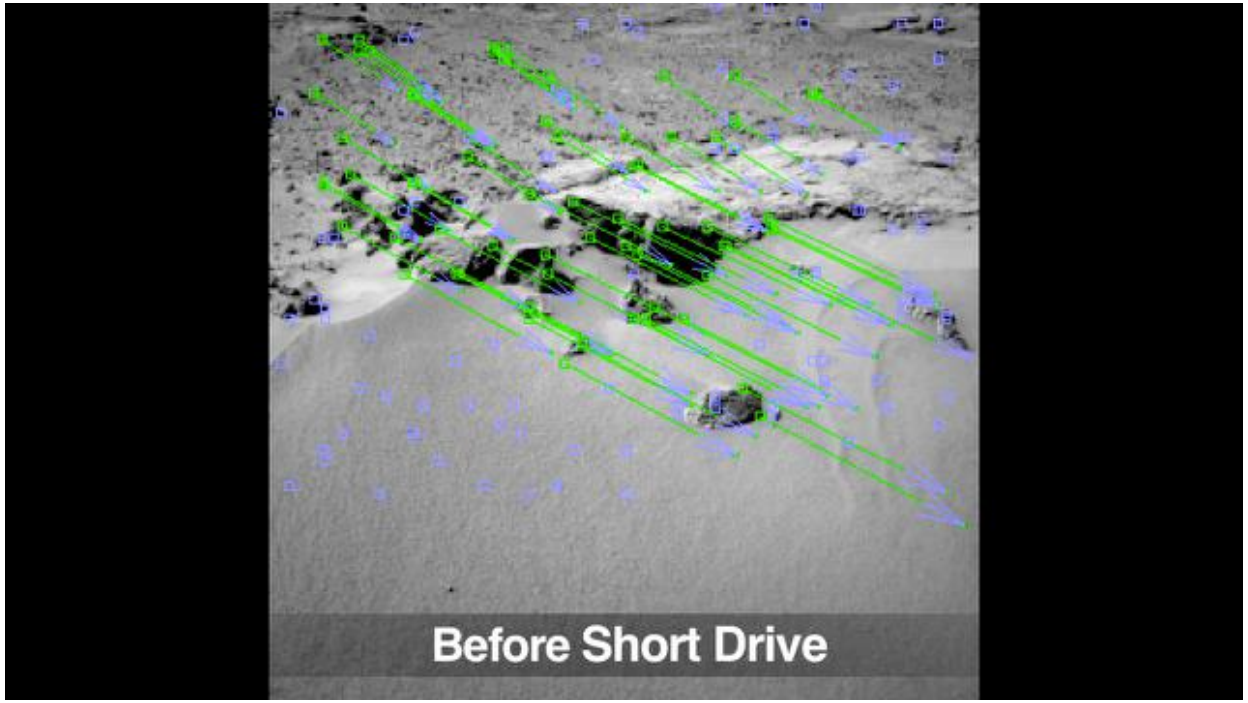
Rover Operations: Sol by Sol…



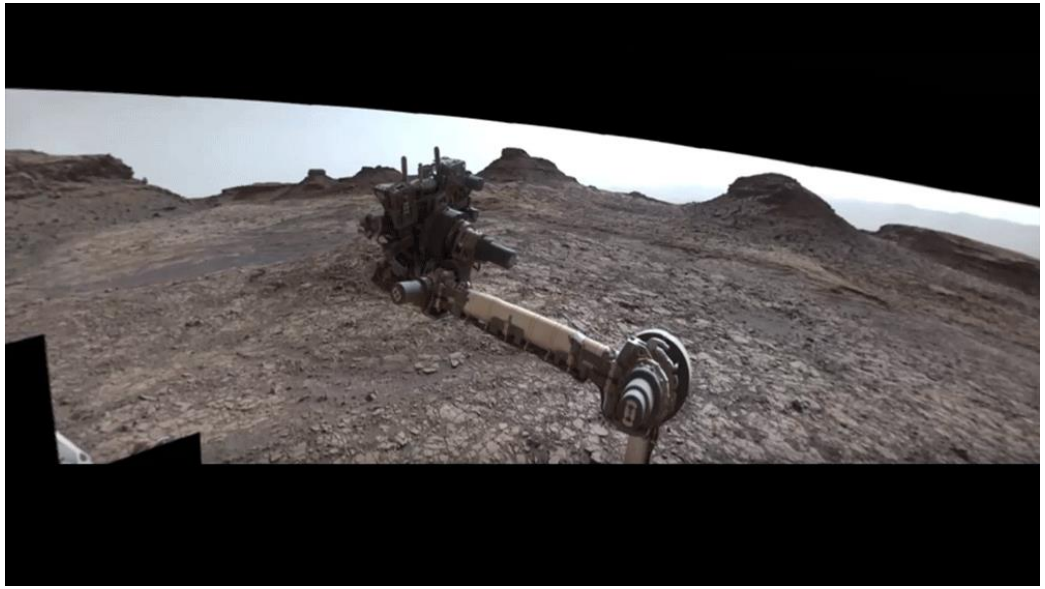
Rover Navigation

AutoNav

Visual Odometry

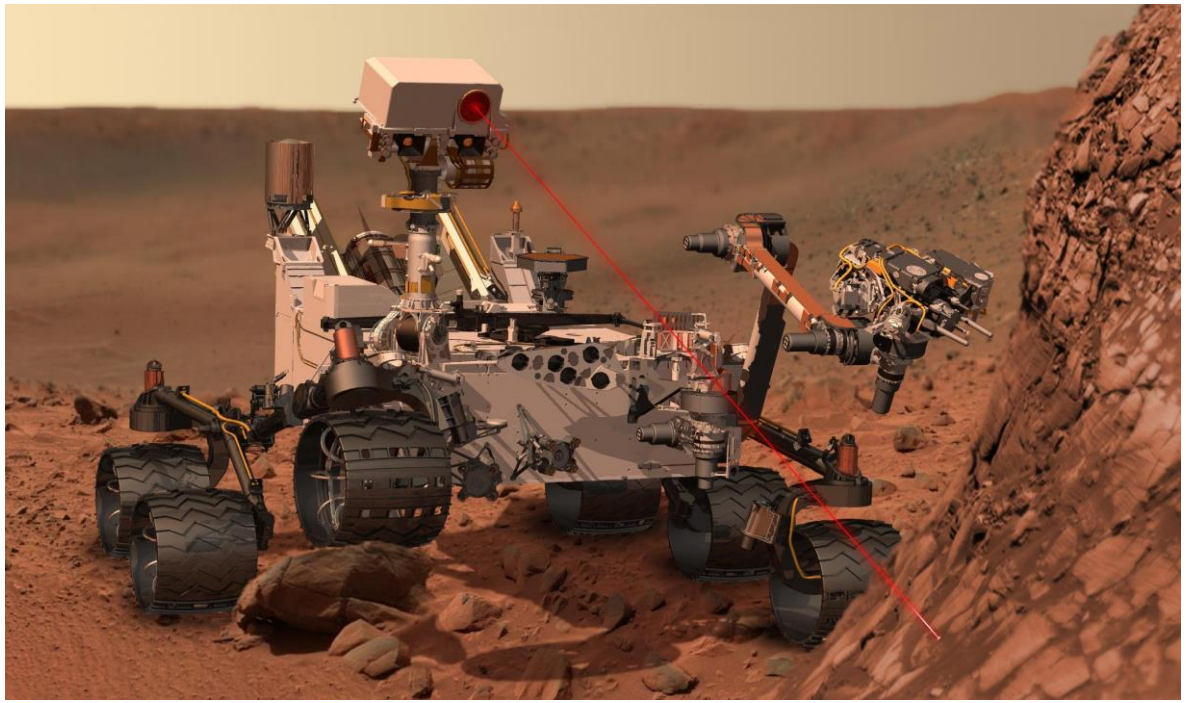


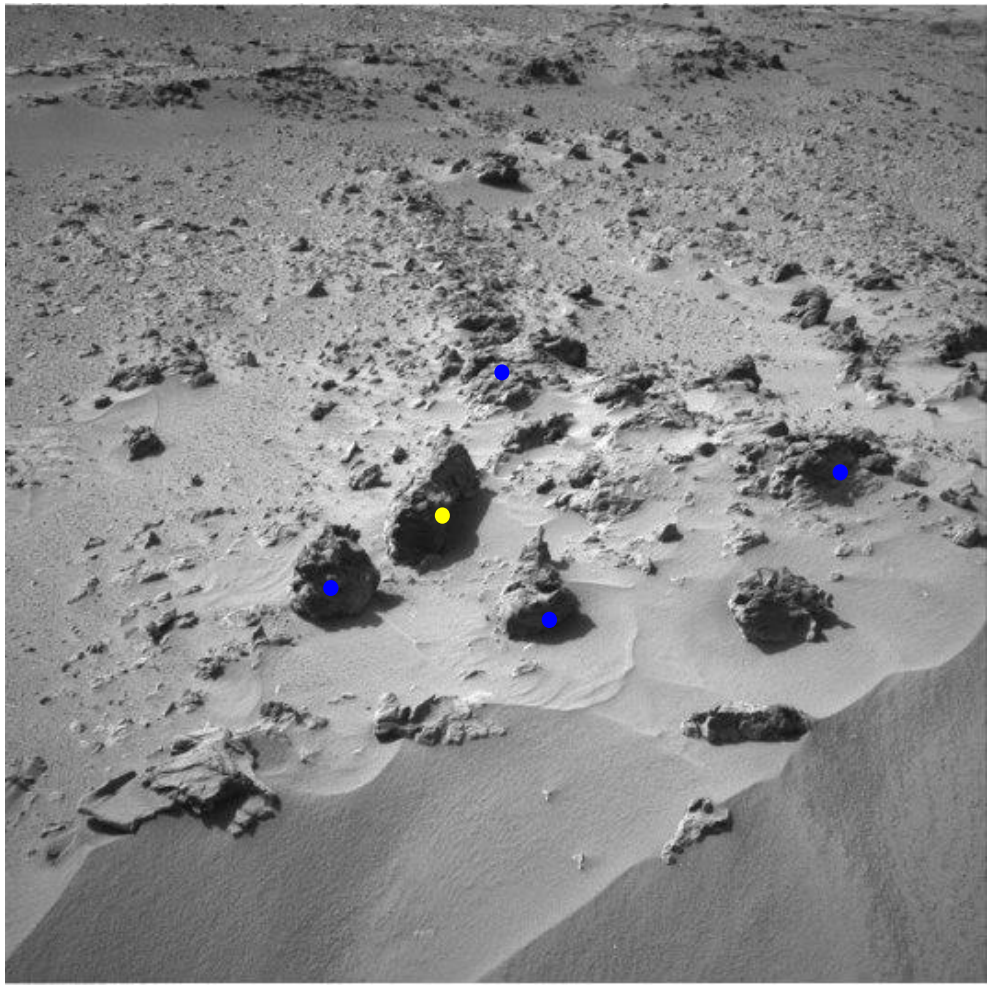
Challenging Terrain…



Intelligent Science Acquisition

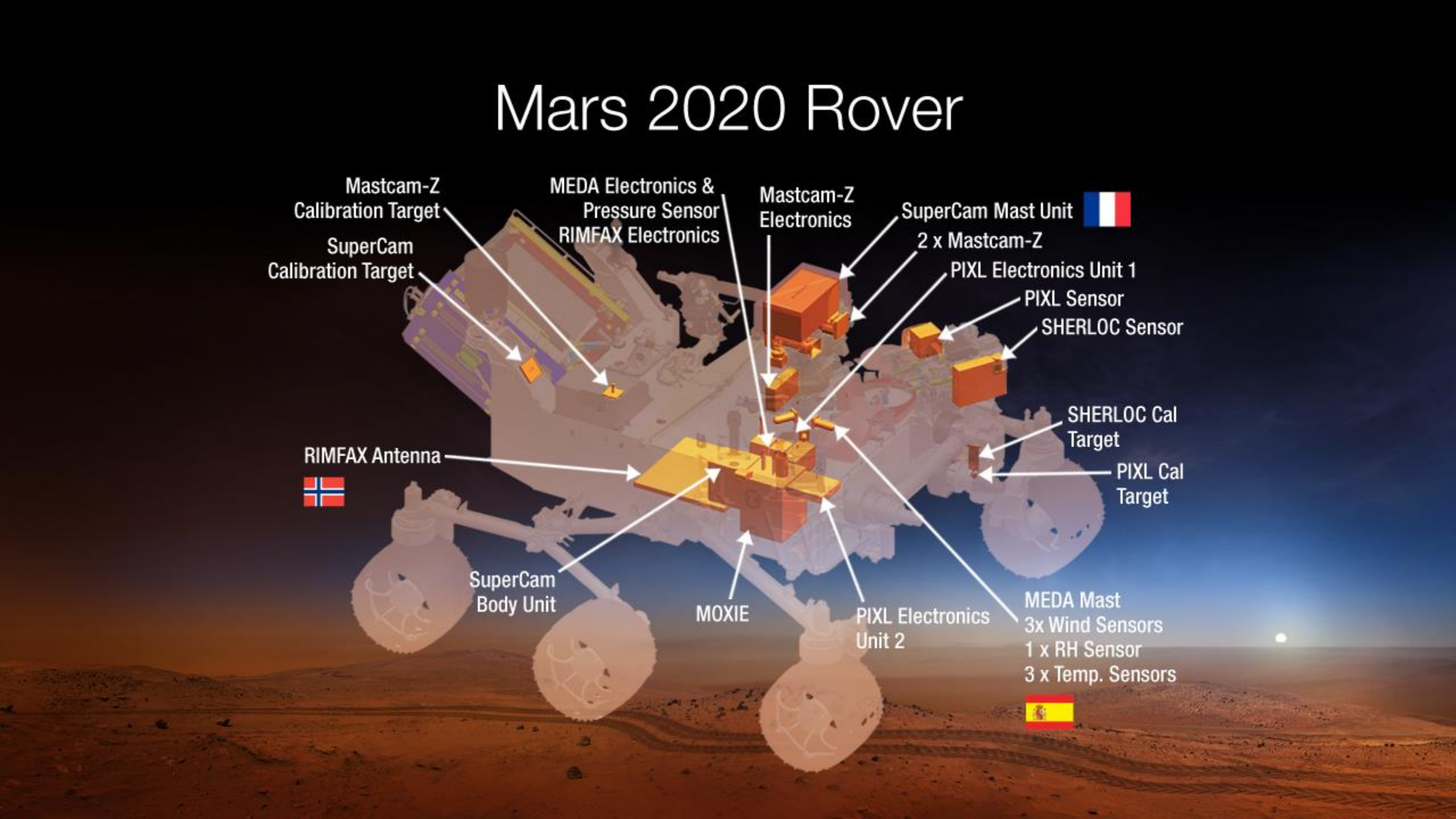
- AEGIS = “Autonomous Exploration for Gathering Increased Science
  - Currently supporting autonomous targeting of Curiosity ChemCam instrument



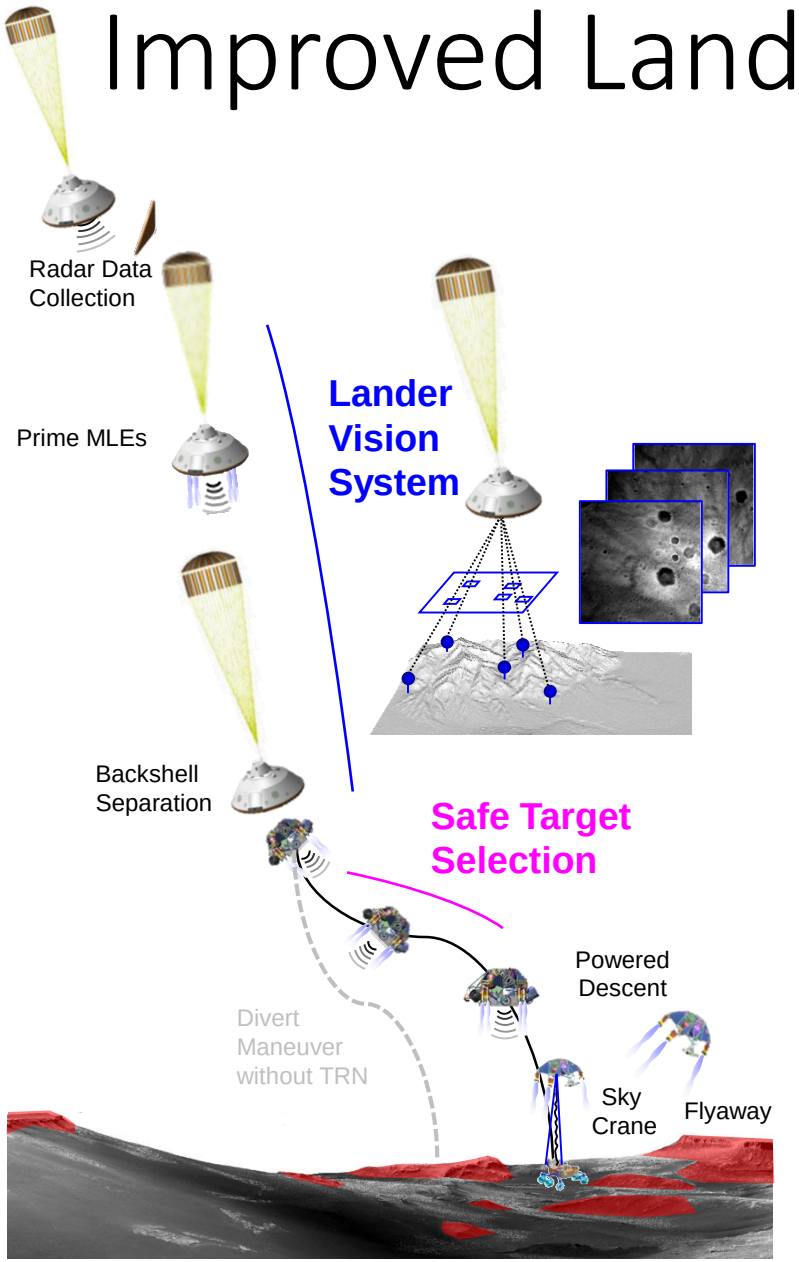


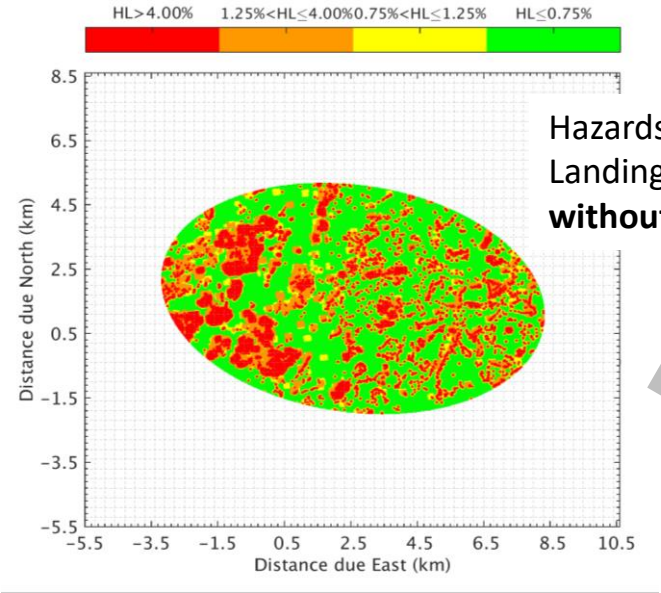
POC: Tara Estlin/JPL

Mars 2020 Rover



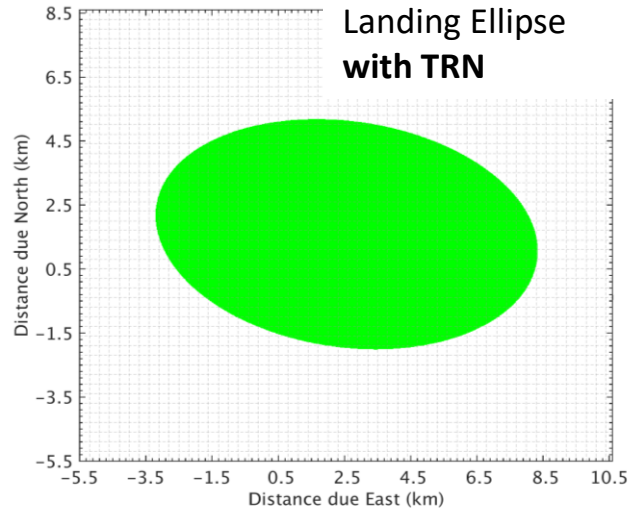
Improved Landing: Terrain-Relative Navigation





Hazards in Landing Ellipse **without TRN**

Hazards in Landing Ellipse **with TRN**



Mars Sample Return – Notional Architecture

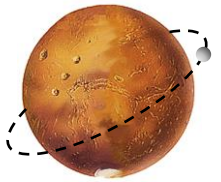
Mars 2020

- Select & Acquire Samples
- Deposit samples for future retrieval

Sample tube on Mars surface

MSR-Lander Concept

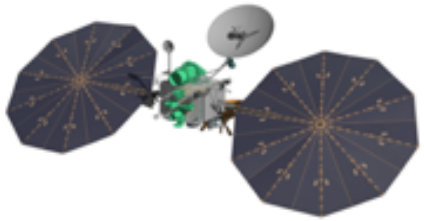
- Small Fetch Rover to Retrieve Samples
- Small MAV on Fixed Platform
- Launch Samples from Mars Surface to ~500km Orbit



Orbiting Sample (OS) canister in Mars orbit

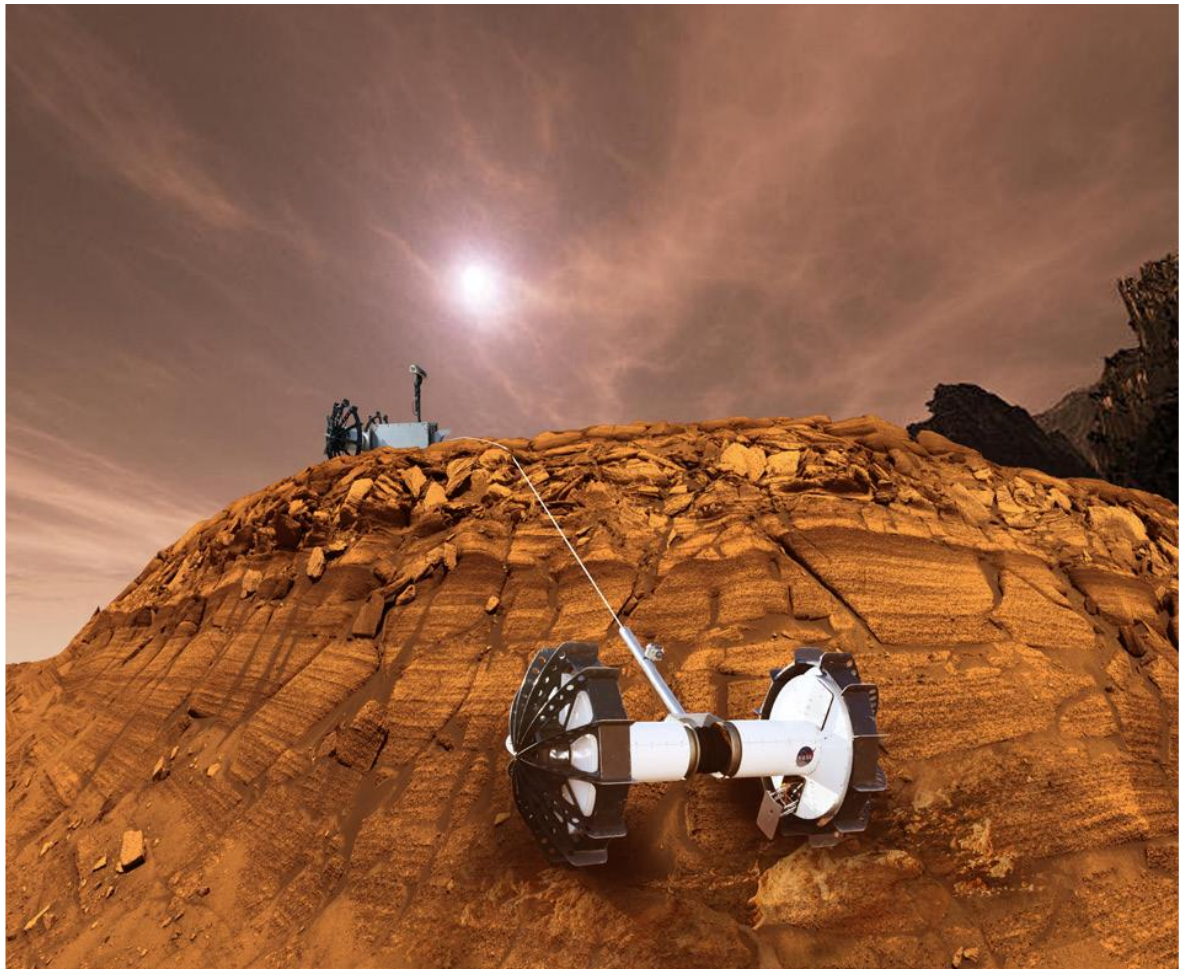
MSR-Orbiter Concept

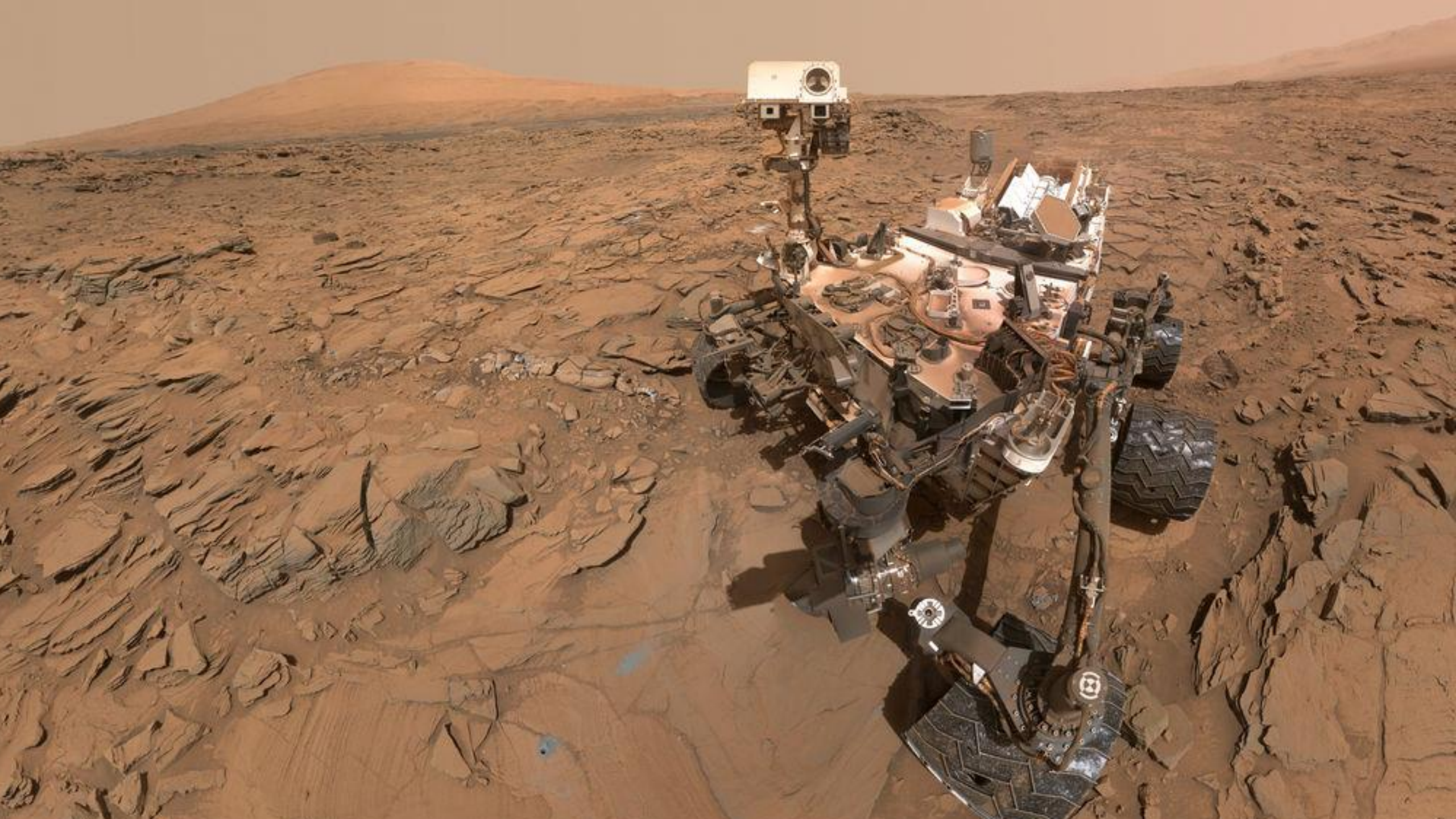
- Rendezvous & Sample Containment
- Return to Earth
- Earth Entry Vehicle



Sample returned to earth

Rapelling Rover Concepts for Extreme Terrain Access





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